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THE JOURNAL OF PHILOSOPHY

ON THE DEFINITION OF THE CAUSAL RELATION [1]

IN a recent paper in *Mind*,[2] Professor Arthur W. Burks has made an interesting proposal for the construction of a logic of causal propositions. Such a logic is greatly needed, for however completely the word "cause" has been eliminated from epistemology, it is still very much a part of the working vocabulary of most empirical scientists. Professor Burks begins, wisely, by avoiding the Humean controversy, and asks instead whether it is possible to give a clear and consistent explication within a system of logic of the term "cause" as it is used in common speech. While I am wholly in accord with Professor Burks' suggestion that such an explication is possible and useful, my own investigations into the question have led me to a definitional proposal that is somewhat different from his.

1. INTRODUCTION

We shall take as our problem, then, the introduction into a system of logic of a relation between sentences that is equivalent, or as nearly equivalent as is feasible, to the relation of "causation" as that relation is used in scientific writing. A number of points regarding the undertaking should be made clear at the outset:

a. Our undertaking is logical rather than ontological. That is, we wish to be able to assert: "The sentence *A* stands in a causal relation to the sentence *B* (in a specified system of sentences)"; and not: "That which is denoted by sentence *A* causes that which is denoted by sentence *B*." Hence, the causal relation that we shall introduce is in the metalanguage and not in the object language.

b. We shall require that the causal relation be an asymmetrical one—that "*A* causes *B*" be incompatible with "*B* causes *A*." Our requirement will be even somewhat stronger. We shall so define the relation that "*A* causes *B*" is incompatible with "not-*B* causes not-*A*."[3] The reason for the requirement is, again, that we wish

[1] Professors Arthur Burks, Herbert Feigl, Emile Grunberg, Tjalling Koopmans, and Manley Thompson have been most helpful in commenting on earlier drafts of this paper.

[2] Arthur W. Burks, "The Logic of Causal Propositions," *Mind*, Vol. LX (1951), pp. 363–382.

[3] This is one fundamental departure of the present proposal from that of Professor Burks, whose causal relation is asymmetrical, but only in the sense that the implication relation is asymmetrical. Thus, in his system, from "*A* causes *B*" it follows that "not-*B* causes not-*A*." (*Op. cit.*, p. 369.)

to keep as close as possible to ordinary usage. Ordinary usage does not sanction: "If the rain causes Jones to wear his raincoat, then Jones' not wearing his raincoat causes it not to rain."[4]

c. We shall avoid the usual assumption that the asymmetry of cause and effect has something to do with sequence in time. From the proposition that "*A* causes *B*" it will not be possible to draw any inference as to the time sequence of the events denoted by *A* and *B*, respectively. The reason is that in many instances where the scientist speaks of cause (e.g., "force causes acceleration") no time sequence is involved.[5]

d. Initially, we shall restrict our definition to models of experimental systems—that is, systems in which an experimenter can alter the values of certain variables, or the truth-values of certain propositions. I think it can be verified that in scientific literature the word "cause" most often occurs in connection with some explicit or implicit notion of an experimenter's intervention in a system. The word is used frequently in experimental physiology, seldom in astronomy. After the definition has been developed fully, this point will be discussed further.

2. Construction of the Definition

Our construction of a logic of causality will be limited initially to the calculus of propositions, and, indeed, to systems involving a finite number of atomic sentences. This restriction will permit us to deal with the problem in its barest essentials, and even so we shall not find it lacking in complications.[6] We begin with a set of n atomic sentences, $a_1, \ldots, a_n$, which are assumed to be empirical and logically independent. We define as a *state-description* a molecular sentence (a) that is the conjunction of atomic sentences and their

[4] Insofar as it is possible, I shall employ Professor Burks' examples to permit easy comparison between his definition and mine.

[5] Time sequence is integrally involved in Mill's theory of causation. His canons of induction only permit the inference of invariant relation, and to this must be added a time sequence in order to distinguish between cause and effect. It may well be empirically true that, in most or all cases where "*A* causes *B*" is true, *A* precedes *B* in time; but we do not wish to incorporate this requirement in our definition.

[6] In another paper, the author has shown how the same kind of causal relation can be introduced in ordinary algebraic systems of simultaneous equations. See "Causal Ordering and Identifiability," Chapter 3 in T. Koopmans (ed.), *Econometric Methods* (Cowles Commission Monograph 14), forthcoming. A similar definition has been arrived at independently by Professor Guy Orcutt of Harvard University. See his abstract, "The Influence of Causation," *Econometrica*, Vol. 19 (January, 1951), p. 60. A definition along the same lines, but developed less formally, was proposed by Lewis A. Dexter, "Causal Imputation and Purposes of Investigation," *Philosophy of Science*, Vol. 6 (1939), pp. 404–410.

negations, and (b) in which each atomic sentence or its negation (but not both) appears once (e.g., $a_1 . -a_2 . \ldots a_{n-1} . -a_n$.).[7] A state-description designates a *state*. In saying that the sentences are empirically testable we mean that we can determine empirically which state-description is true; and in saying they are logically independent we mean that no state-description is self-contradictory.

We define as an *empirical law* a molecular sentence formed from one or more of the n atomic sentences. We describe a state-description, S_i, as *realizable* (i.e., the corresponding state is empirically possible) relative to a set of laws, $P_1, \ldots, P_k$, if $P_1 . P_2 \ldots P_k . S_i$ is not self-contradictory.[8]

A set of empirical laws is *complete* for a set of atomic sentences if only a single unique state-description is realizable relative to this set of laws—i.e., if $P_1 \ldots P_k . S_i$ is self-contradictory except for a single state-description S_j. The empirical laws form a *minimal complete set* for the atomic sentences if no proper subset of the laws is complete for that set of sentences.

Example: Let a be the atomic sentence stating that a lighted match is observed in a room at time t; b the atomic sentence stating that an explosion is observed to occur in the room at time t. Then the state-descriptions are: $a.b$, $-a.b$, $a.-b$, and $-a.-b$. Let A be the empirical law defined by: $A \equiv a$; let B be the empirical law defined by: $B \equiv .-avb$. Then $a.b$ and $a.-b$ are realizable relative to A; $a.b$, $-a.b$, and $-a.-b$ are realizable relative to B; while only $a.b$ is realizable relative to the set comprised of A and B. Hence, this latter set is a complete set, and indeed a minimal complete set, for the atomic sentences a and b.

The state-descriptions that are realizable relative to a set of laws characterize the set extensionally. Hence, if we substitute for a set of laws another set that is extensionally equivalent, the set of state-descriptions that is realizable will remain invariant. For example, define: $A' \equiv b$ and $B' \equiv .a \equiv b$. Then only $a.b$ is realizable relative to the set comprised of A' and B', and $A'.B'$ is equivalent to $A.B$.

However, it does not follow that, if we have two sets of laws that are extensionally equivalent, we can set up a one-one correspondence between the *individual* laws comprising the two sets, such that the members of each pair are extensionally equivalent. In the previous example, A' is equivalent to neither A nor B; nor is B' equivalent to A or B. We may express this by saying that if two

[7] Cf. Rudolf Carnap, *Introduction to Semantics* (Cambridge: Harvard University Press, 1942), p. 105.

[8] Cf. Carnap, *op. cit.*, pp. 95–97.

sets of laws are extensionally equivalent, yet the sets need not be isomorphic.

Now we propose to define causality in terms of this notion of isomorphism. Given a set of atomic sentences, and a minimal complete set of laws for them, we wish to specify what causal relations among the sentences are implied by these laws. To accomplish this we will need one more definition.

We will say that a set of empirical laws *determines* an atomic sentence, a_k, if only state-descriptions in which a_k appears or only state-descriptions in which $-a_k$ appears are realizable relative to this set of laws. Then a complete set of laws for a set of n sentences determines, simultaneously, all n sentences.

For a complete set of laws, $P_1, \ldots, P_k$, form the smallest subset, R_1, that determines a_1, the smallest subset, R_2, that determines a_2, and so on. Then we will say that a_j has causal precedence over a_i if the set R_j is properly included in the set R_i. We will say that a_j and a_i are mutually dependent if R_j and R_i are identical; we will say that a_j and a_i are independent if R_j and R_i are disjunct.

Taking again the propositions a and b, and the laws A and B as example, we find that (A) is the smallest set that determines a and (A, B) is the smallest set that determines b. Since (A) is included in (A, B), it follows that a has causal precedence over b—we can say (elliptically) that "the lighted match causes the explosion." On the other hand, taking the extensionally equivalent laws A' and B', we find that, relative to these, b is determined by (A') and a by (A', B'). Hence, b has causal precedence over a relative to the set of laws (A', B').

This completes the first formal definition of the causal relation. We see that it is a relation in the metalanguage that induces a partial ordering among the members of a set of atomic sentences. Moreover, this ordering is defined relatively to a minimal complete set of molecular sentences (laws) that determines a single state-description of the atomic sentences as realizable. Finally, the ordering may be altered if for the original set of laws we substitute a different, but extensionally equivalent set.

3. Some Examples of Causal Relations

The meaning of the proposed definition may be clearer if illustrated by two more examples:

(I) Let a be: "It is raining." Let b be: "John is wearing his raincoat." Let $A \equiv a$, and $B \equiv .a \equiv b$. Then (A, B) is a minimal complete set of laws for (a, b). Again a is determined by (A), and b by (A, B); hence, by definition, a causes b—"Rain causes John to wear his raincoat." Suppose now that we have $-A$ instead of A.

Now $(-A, B)$ is a minimal complete set of laws for (a, b). In this case we can still say that "rain causes John to wear his raincoat," but we can express the new situation more felicitously by the counterfactual conditional: "If it had rained, John would have worn his raincoat."

We see from this example that the causal relation rests, not upon the truth or falsehood of a or b, but upon (i) the assumed "lawful" connection between them expressed by B, and (ii) the "independent" determination of a expressed by A or $-A$.[9] Perhaps the best way of expressing the relation is by saying: "The state of the weather is the cause of John's attire."

(II) Consider next a slightly more complicated example. Let a be: "There is more than the usual rainfall this year"; b: "The wheat crop is large this year"; c: "The price of wheat is low this year." Take as laws: $A \equiv a$; $B \equiv .a \equiv b$; and $C \equiv .b \equiv c$. Then we can say: "The large rainfall caused a large wheat crop, and this caused the price of wheat to be low." A may be regarded as extensionally equivalent to the whole concatenation of initial conditions and laws that determines the weather; B to the botanical laws governing the growth of wheat; and C to the demand function determining the price at which a wheat crop can be sold. In this case, again, A can be replaced by $-A$ without disturbing the causal ordering. Likewise, B can be replaced by $-B$ (the causal ordering would be the same with a variety of wheat that was drought-resistant but damaged by excessive moisture); and C can be replaced by $-C$ (the causal ordering would be the same if there were a positive rather than a negative demand relation between quantity and price).

4. The Problem of Invariance

Before we can regard this explication of the causal relation as satisfactory, several questions must be answered. These concern the notion of "lawful connection," and the related notion that one or more of our atomic sentences (in our examples, sentence a) can be determined "independently" of the others. We do not propose to deal with the problem of confirmation of laws, but only with problems of their *meaning*.[10]

[9] This explains why, in distinction to other explications of the causal relation (e.g., that of Burks, *op. cit.*, p. 369), ours does not permit the inference of "$-b$ causes $-a$" from "a causes b." Definitions of cause that interpret that relation as somehow analogous to the relation of implication can hardly be expected to avoid this difficulty.

[10] The importance of settling the question of meaning prior to the question of confirmation has been pointed out by Elizabeth Lane Beardsley, "'Non-Accidental' and Counterfactual Sentences," *Journal of Philosophy*, Vol. XLVI (September 1, 1949), pp. 573–591.

From the formal standpoint, the questions just raised may be regarded as questions of uniqueness and invariance. There are, in fact, two such questions: (i) whether the smallest subsets determining the atomic sentences are unique; and (ii) whether all extensionally equivalent complete sets of laws yield the same causal ordering of the atomic sentences.[11] We have already obtained a negative answer to the second question, but before pursuing it further we wish to deal briefly with the first.

a. It is easy to find an example of non-uniqueness of the smallest subset determining an atomic sentence. Consider a system comprised of three atomic sentences, a, b, and c, and two laws, $A \equiv a.b$, and $B \equiv b.c$. The set of laws (A, B) is a minimal complete set for the sentences (a, b, c); but both (A) and (B) are smallest sets determining b.

To assure uniqueness of the causal ordering with respect to a set of empirical laws, we must insist that if there are two subsets, S_i and S_i', determining the same atomic sentence, a_i, then one of the subsets must be included in the other. A minimal complete set of empirical laws satisfying this requirement for all the atomic sentences will be called *consistent*.

b. Reverting to the match-explosion example, we have seen that we arrive at "the lighted match causes the explosion" or "the explosion causes the lighted match" depending on whether we take (A, B) or (A', B') as the complete set of empirical laws. The first choice corresponds to everyday language, the second certainly does not.

To see what is involved, let us reverse the question. What do we wish to convey when we say: "The lighted match caused the explosion" in addition to what we wish to convey by: "A lighted match was observed, and an explosion was observed"? It will be argued here that what we wish to convey by the first is precisely: "$A.B$", while what we wish to convey by the second is "$a.b$". But since the two statements are extensionally equivalent, what is meant by the distinction?

One possible meaning is that in the first case we wish to indicate that realization of the state $a.b$ is a selection of a particular state out of the whole set of states ($a.b$, $-a.b$, and $-a.-b$) that are realizable relative to B. In the second case we wish merely to denote realization of the state $a.b$ without reference to a wider set of states. This is perhaps true, but certainly vague. In particular, the notion of the "selection" of a state from some set of "realizable" states might

[11] The second question, *re* properties invariant over the group of extensionally equivalent laws, is discussed by Carnap, *Logical Foundations of Probability* (Chicago: University of Chicago Press, 1950), pp. 146–147.

be suspected of harboring objectionable metaphysics. In a deterministic world, only one state is realizable—that which is the fact. The natural laws are not relaxed from time to time to permit this act of selection.[12] As Mach says: "The universe is not *twice* given, with an earth at rest and an earth in motion; but only *once*, with its *relative* motions, alone determinate. It is, accordingly, not permitted us to say how things would be if the earth did not rotate."[13]

To deal with this apparent paradox, we shall have to complicate, slightly, the system of definitions outlined in Section 2. This we proceed to do next.

5. Elaboration of the Definition

For the present purpose, we require an object language with a finite number of one-place predicates, $a_1(\ ), \ldots, a_n(\ )$, in one-one relation with our original set of atomic sentences. We need an individual variable, t, which may be interpreted as the *time*, or more generally, the "location" of events. Then our new atomic sentences (*observation-sentences*) will be of the form: $a_i(t)$—the sentence a_i of our original language holds at "time" or "location" t. We now introduce a second set of predicates, $A_1(\ ), \ldots A_k(\ )$, also admitting the t's as their arguments, which we will refer to as *condition-sentences* or, more briefly, *conditions*. That is, $A_1(t_1)$ means that the first condition holds at time t_1. The A's, like the a's, are assumed to be empirical sentences, and the entire set of A's and a's, taken jointly, to be logically independent. In this language, a state-description for time t is constituted by a conjunction of atomic sentences in which each $A_i(t)$ or its negation (but not both), and each $a_i(t)$ or its negation (but not both), appear. We introduce the additional concept of a *conditional state-description:* a conjunction of atomic sentences in which each $a_i(t)$ or its negation (but not both) appears. The language is supposed to contain also a universal quantifier, so that we can construct sentences of the form: $(t)\ (\ldots)$.

We now define as an *empirical law* a quantified sentence of the form:

$$(t).A_i(t) \supset f_i(a_1(t), \ldots, a_n(t)),$$

where $f_i(\ldots)$ is a molecular sentence formed of the a's. We also define a conditional state-description as realizable relative to a set of laws if the conjunction $f_1 \ldots f_k$, of the f's appearing in the set of

[12] Hence, it is not a satisfactory answer to limit causal notions to experimental situations, since the behavior of the experimenter is presumably also governed by law.

[13] Ernst Mach, *The Science of Mechanics* (La Salle, Ill.: Open Court, 1941), p. 284.

laws, does not imply the falsity of the conditional state-description. It is important to note that in the present language, a sentence of the form $(t)\ A_i(t) \supset f_i$ is an empirical sentence, while in the original language, sentences of the form $A \equiv f(a, b)$ were definitional, and hence tautologous.

We will say that a set of conditions (and a corresponding set of laws) *determines* an atomic sentence, a_j, if (i) we have an empirical law for each condition in the set, and (ii) in the set of states for which all these conditions are T, a_j is either always T or always F. We define a complete set of laws as one that determines a unique conditional state-description—i.e., determines all the a's. Given a complete set of laws, we will say that a_j has causal precedence over a_i if the minimal set of laws determining the former is a proper subset of the minimal set of laws determining the latter. (For uniqueness, we must again impose a consistency requirement on the set of laws.)

In our present formulation, there is no difficulty in speaking of the realizability of states. For if the A's are not invariant with respect to time, but if at any given time we have a sufficient number of A's holding to provide a complete system of laws, then at each t, a particular conditional state will be T, but at different times different conditional states will be T. We can guarantee that the proper number of conditions will be T at any time by the following device: corresponding to each condition, A_k, we will postulate a whole family of "related" conditions, A_k, B_k, C_k, ... such that one and only one is T at any given t.[14] Now we construct a set of laws by selecting a law corresponding to one (and only one) condition in *each* such family. We require that every such set be consistent and complete.

Our system may seem rather special in that it does not admit any laws that relate atomic sentences for two different points in time. This is easily remedied. It is not necessary that a sentence of the form $a(t)$ denote an event *occurring* at time t, but only that it denote an event *referred* to time t. Thus, the sentence $a(t)$ might mean that a particular body had a particular position two seconds before t. In this way all the laws of dynamics that are invariant with respect to translations of the origin of time can be accommodated.

6. The Problem of Invariance Re-examined

In our first language we were confronted with the problem that the causal ordering was, in general, non-unique because we could

[14] This notion is analogous to Carnap's "family of related properties" (*Logical Foundations of Probability*, pp. 76–77).

always find a number of minimal complete sets of laws extensionally equivalent to any given minimal complete set but inducing different causal orderings among the atomic sentences. But in our second language, two minimal complete sets of laws determining the same *conditional* state will not, in general, be extensionally equivalent.

To illustrate this, let us elaborate the match-explosion example. As $A_1(t)$ we take the sentence: "A match is struck at time t, it is dry, there is oxygen present, etc." As $A_2(t)$, we take: "A space is filled at time t with an explosive mixture of gases." Here "explosive" must be supposed to be defined by the chemical composition of the gases. As $a_1(t)$ we take: "A lighted match is in the space an instant after t"; and as $a_2(t)$: "An explosion occurs in the space an instant after t." We postulate empirical laws corresponding to the two conditions:

$$A_1(t) \supset a_1(t);\ A_2(t) \supset .a_1(t) \equiv a_2(t).$$

The two conditions, together with the two observation-sentences, define $2^4 = 16$ logically possible states. Only the nine states listed in the following truth-table are realizable relative to the laws. (If both conditions are T, then only the conditional state $a_1 . a_2$ is realizable; if the first condition is T, the second F, two states are realizable; if the first condition is F, the second T, two states are realizable; and if both conditions are F, four states are realizable.)

$A_1(t)$	$A_2(t)$	$a_1(t)$	$a_2(t)$
T	T	T	T
T	F	T	T
T	F	T	F
F	T	T	T
F	T	F	F
F	F	T	T
F	F	T	F
F	F	F	T
F	F	F	F

Now consider an alternative set of laws:

$$A_1(t) \supset .a_1(t) \equiv a_2(t);\ A_2(t) \supset a_2(t).$$

Can we distinguish empirically between the new set of laws and the original set? Again, if both conditions are T, then only the conditional state $a_1 . a_2$ is realizable. But if one or both of the conditions is F, the states that are realizable are not the same as before. This

is exhibited by a truth-table that shows which states are realizable if the new laws are empirically valid.

$A_1(t)$	$A_2(t)$	$a_1(t)$	$a_2(t)$
T	*T*	*T*	*T*
T	*F*	*T*	*T*
T	*F*	*F*	*F*
F	*T*	*T*	*T*
F	*T*	*F*	*T*
F	*F*	*T*	*T*
F	*F*	*T*	*F*
F	*F*	*F*	*T*
F	*F*	*F*	*F*

If, for example, we can find a t such that $A_1.-A_2.a_1.-a_2$, then we know that the second set of laws is not valid. It is possible, of course, that the first set of laws is not valid either, but the point remains that the two sets of laws are not extensionally equivalent.

We see that the empirical testability of laws (and the empirical significance of causal ordering) is intimately connected with the contingent character of laws, and with the fact that the conditions that constitute antecedents of laws are not T at all times.[15] Herein lies the rationale of experimentation—it is a procedure for systematically varying the conditions that hold, and hence for producing observations of situations in which not all the conditions in a complete set of laws hold simultaneously. The observations permit an empirical choice to be made between two complete sets of laws that determine the same state.

The experiments may, of course, be performed by nature. Reverting to the match-explosion example, nature may provide at various times and places examples of all the nine conditional states that are empirically realizable relative to the original laws, and no others. While this does not prove the validity of these laws, it serves to rule out many alternative explanations for the observation that at some t we have $A_1.A_2.a_1.a_2$.

7. Operational Significance of the Definition

Have we succeeded in providing a satisfactory explication of the causal relation? The question is not one that can be answered

[15] From this it may be seen that if our explication of the causal relation is acceptable, it provides a basis for a treatment of the counterfactual conditional. Cf. Nelson Goodman, "The Problem of Counterfactual Conditionals," *Journal of Philosophy*, Vol. XLIV (1947), pp. 113–128.

definitively. The test is whether a relation of the kind we have defined holds in those cases where scientists speak of one observable as "causing" another. In the examples that have been given in this paper, the explication appears to be consistent with ordinary usage. Moreover, it appears to avoid at least one of the fundamental objections (the reversal of the ordering through negation) that can be raised against earlier definitions. The reader will presumably wish to test the definition further with examples of his own.

One point deserves further examination. The determination of the causal ordering depends in a fundamental way upon the distinction made in the previous section between conditions and observation-sentences. From an empirical standpoint, both observation-sentences and conditions are atomic sentences whose truth or falsehood depends on empirical evidence. We have not given any basis for classifying a particular atomic sentence as one or the other. If the classification is purely conventional, then the causal ordering is equally conventional. I have not arrived at an entirely satisfactory answer to this question of classification, but can make two suggestions that may provide a basis for further exploration.

a. In experimental situations, certain atomic sentences may denote behaviors of the experimenter. If we call these sentences "conditions," then the remaining sentences may be regarded as "observation-sentences" that are indirectly, but not directly, determined by the behavior of the experimenter. While this procedure appears to agree very well with the use of "cause" in experimental situations, it rules out statements like "rain causes trees to grow in the Amazon basin." If we accept this limitation, then we admit that any extension of causal language to non-experimental situations is metaphor and anthropomorphism.

b. In non-experimental situations, all we are given at the outset is the fact that of all the logically possible states, only some subset has been empirically realized. Let us make the further assumption that we are justified in regarding the realized states as the only ones that are realizable. (More precisely: let us formulate laws with respect to which only those states that have been realized are realizable.)

In order to distinguish between conditions and observation-sentences, we must find some asymmetry among the different columns of the truth-table describing the realizable states. That is, columns belonging to atomic sentences that we wish to classify as conditions must be distinguishable, on the basis of intrinsic criteria, from columns belonging to observation-sentences.

I propose the following criterion:

Given n atomic sentences, and given a truth-table displaying the states that are realizable, select any subset of k atomic sentences, designating the members of this subset by $A_1, \ldots, A_k$, and the remaining atomic sentences by $a_1, \ldots, a_m$ $(m=n-k)$. Define a conditional state of the a's as before. Consider the subset $S(B)$, of conditional states that are realizable when a particular subset, B, of the A's are T (and the remainder F). The set of A's will be called an admissible set of conditions if the sets $S(B)$ satisfy the following requirements: (1) $S(O)$ has 2^{n-k} members (i.e., all conditional states are realizable when all the conditions are F); (2) $S(B)$ has 2^{n-k-g} members when B has g members; (3) $S(B_1 \vee B_2) = S(B_2).S(B_1)$, where B_1 and B_2 are any two subsets of conditions. The last two requirements mean that the conditional states that are realizable when both a set of conditions, B_1, holds and a second set of conditions, B_2, holds, are those which are realizable both when B_1 alone holds and when B_2 alone holds—the laws are in this sense "additive."

Now an examination of the first truth-table for the match-explosion example shows that the sentences A_1 and A_2 constitute a set of admissible conditions, and, indeed, the *unique* set. It is not, unfortunately, the case that every such truth-table will possess a set of admissible conditions, or if such a set exists, that it will be unique. Perhaps some modification of the requirements would remedy these defects, or perhaps the causal ordering should be regarded as defined only in those instances where these rather restrictive requirements are satisfied.

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BOOK REVIEWS

Morals and Law; the Growth of Aristotle's Legal Theory. MAX HAMBURGER. New Haven: Yale University Press. 1951. xxii, 191 pp. $3.75.

Dr. Hamburger's book has four closely related and mutually developed themes. The first, around which the others are organized, is concerned with the problem of the place of the *Magna Moralia* (MM) in the writings of Aristotle. The second theme is concerned with the growth of Aristotle's legal theory measured in terms of its relations to Platonic legal theory and of its internal maturation. A third theme, developed more casually than the others, seeks to show the use made of Aristotle in later legal history, especially in

Roman legal theory. The fourth theme develops the significance of Aristotle's legal concepts in relation to contemporary legal theory.

The generally held view of the place of MM is that of W. Jaeger and of his pupil, R. Walzer. This school holds MM to be a work of a follower of Theophrastus whose interest was strongly juridical. The *Eudemian Ethics* (EE), on the other hand, is considered as an early work of Aristotle which was followed by the *Nichomachean Ethics* (EN). Dr. Hamburger's analysis is directed against this view. He seeks to show that MM is genuine, that it is the "Urethik," and is succeeded by EE and EN. In this view he returns full cycle to the view of Schleiermacher and to the view, more recently expressed, of von Arnim. Dr. Hamburger makes his analysis on the basis of the correctness of Jaeger's position that EE is a genuine work of Aristotle, that it precedes EN, and that MM shows a strong juridical emphasis. He seeks to show, however, that it is precisely in its juridical aspects that MM stands at a more primitive level of development than EE or EN, and that there is a developmental relationship between them which exhibits the growth of Aristotle's legal theory.

The comparative analysis made of the juridical sections of the ethical treatises is divided into three parts: the theory of voluntary and involuntary acts (theory of culpability); the theory of general justice and of distributive, remedial, and exchange justice, together with the classification of legal spheres, the theories of crime, the concepts of the lawful man and of equity; the third section, under the rubric of *Philia* develops Aristotle's theory of associations—community, partnership, and contract. Each section is preceded by an illuminating synoptic tabulation of the treatment of the topics in each of the ethical treatises. Within each section the attempt is made to show that in terms of length, refinement of definition, presence and absence of juridical matters of moment a strong probability arises that MM is a relatively early statement of Aristotle's ideas. It is tinged with the uncertainty that marks a break with the Platonic school and that marks an initial forging of a distinctive theory of law. Simplified statements in MM are shown to be poor expressions of refined analyses of EN; illustrations in MM not found in EN are shown to be difficult to account for in the Jaeger-Walzer hypothesis; extended and loose statements in MM are found as clear definitions in EN; statements summarizing doctrines to be found in EE and EN are shown to be much closer to the less precise formulations of EE; doctrines common to all three are shown to take on a more juridical tone and to be more legally accented and oriented in EN and the later works, the *Rhetoric* and *Politics*.

While considerable persuasive force is thus accumulated from this analysis of the legal elements of the ethical treatises for the correctness of the von Arnim contention, the argument does not completely succeed on the basis on which Dr. Hamburger wished to build, namely the exhibition of the "growth" of Aristotle's ideas. While Dr. Hamburger makes every effort to show this growth in most of the topics he discusses, the evidence or arguments presented for the legitimacy of calling all the differences pointed out affairs of evolution or growth is not conclusive. This would have been difficult to provide in any case, but it is especially so where the point to be proved is an order in time of the writings studied. Where this order is given, one may then look on such matters as expansion, refinement, and abridgment as indicative of evolution. Where this order cannot be taken for granted, such external factors remain ambiguous with reference to a direction of change. Dr. Hamburger offers as an illustration of growth the development of Aristotle's doctrine of Philia. Yet the change from MM to EN is not convincingly shown to be more than that of expansion and clarification by the addition of topics and of details. There is considerable difference in length, the earlier containing 17 as against 24 chapters in EN. The major topics and the order of their treatment remain approximately the same. More important, there are no basic additions or transformations of ideas. One of the major evidences of difference is in the treatment of the problems that arise in connection with equality and inequality of friendships, especially within friendships of utility which are closely related to business relations. Whereas MM merely states the general principles to be applied in such conflicts, EN goes into the casuistry of the principles; the principles are not shown to be significantly altered unless the increased juridical emphasis, natural enough if decision problems are discussed in detail, can be so construed.

To follow the growth of a thinker's ideas is normally a very important aid to understanding. With reference to the present problem, it might even be regarded as an external test of growth. The careful treatment Dr. Hamburger makes of the differences between MM and EN, however, did not add very much to this reader's understanding of the finished doctrine. Dr. Hamburger's treatment of Aristotle's legal theory and of the place it occupies in his social philosophy is exceptionally fine. It is among the best available. It appears to be constructed, however, much more on the basis of a sensitive and careful study of the ideas to be found in EN, *Rhetoric*, and *Politics* than on a study of growth.

Dr. Hamburger exhibits Aristotle's legal philosophy as a dynamic theory of the law, the full significance of which is to be found

in the theories of the mean, of Philia, and of equity, and in the deep-rooted interrelationships of these concepts with law and justice. From the doctrine of essential uncertainty in human affairs and the co-implicated doctrine of the mean in action the conclusion follows that

> laws can never be framed in such a way as to cover rightly and completely all possible cases for which they were enacted. Against this natural and necessary insufficiency of the law, epieikeia (equity and fairness) constitutes the functional and material remedy (by equity law is completed, not interfered with). And finally man as a social and political being in his dealings with his fellow men never can or will act on strictly defined rational principles which could be worked out like mathematical formulae. His actions and passions, his thoughts and his feelings are to be tempered by philia, social sympathy or civic friendship, which lies at the root of every kind of association as well as of every kind of contract and results in a vast and manifold network of obligations and duties with which the life of human beings is surrounded.

As indicated by this quotation, Dr. Hamburger somewhat refashions the expression of the primary emphasis of the Aristotelian doctrine to bring it into line with contemporary discussions. It does not, in this reviewer's mind, corrupt the essential quality of Aristotle's philosophy, and though considered by itself it appears onesided, it is complemented, in Dr. Hamburger's account, by the emphasis that is placed on Aristotle's constitutionalism and on the rule of law. Aristotle, the apostle of the mean in law, ethics, and politics, is, in his total social and legal philosophy, the mean between the extremes of those who believe in the complete rationality and possible certainty of law and those who reject the ideal of rationality and certainty almost completely as do, according to Dr. Hamburger, contemporary legal realists and legal pragmatists. The import of all this is the contemporary relevance of the Aristotelian approach and results for the understanding of modern law.

Dr. Hamburger's account of contemporary jurisprudence is brief. It should have been either much longer or much briefer, for as it stands it is a rough and external treatment, especially of the American varieties of jurisprudence. The attempt to contrast Aristotle favorably with such writers as Dewey, following the recent fad developed full scale by Jerome Frank, is woefully inadequate to Dewey and does little to help our understanding of Aristotle. One illustration of this which seemed to be particularly tortured was the rejection of Dewey's method of "inquiry" by showing that in a very early work attributed to Aristotle, the *Rhetorica ad Alexandrum,* Aristotle enumerates three classes of speeches, deliberative, epideictic, and forensic, and adds a supplementary and fourth class denominated "inquiry" (*exetasis*). In his *Rhetoric,* however, "Aristotle dropped this special mode of in-

quiry as obviously impractical." Dr. Hamburger then goes on: "It seems strange that Dr. Dewey should have returned, although in a modified and different way, to a similarly complicated and endless mode of inquiry in spite of the fact that the ancient rhetoricians (following Aristotle) had abandoned the system as impractical" (p. 164). This statement combines two distortions. To view Dewey's method of inquiry without further ado as "fact gathering endlessly" is a strange conception of Dewey. To regard "exetasis," whose meaning seems to be much closer to what we would mean by "cross-examination," as the equivalent of Dewey's inquiry, is to confuse "historia" with "exetasis." It is strange, indeed, to suggest that Aristotle is far ahead of Dewey because he apparently did not believe the method of cross-examination (a method designed to elucidate "intentions, acts, and words which are contradictory to one another or to the rest of the man's life") was practical.

Dr. Hamburger's account of Aristotle's legal theory is deep and sensitive. It deserves to be read. It is not complete, however, and has an element of distortion in it that would have been corrected had Dr. Hamburger taken the opportunity to place Aristotle's legal theory into closer relation with the legal processes of his own time. This has been a general defect in the treatment of Aristotle, and there is need for a thorough treatment of this order. It seems to this reviewer, for example, that in so far as Aristotle significantly reflects Athenian legal experience—the rôle that arbitration plays in legal transactions, the rôles of public officials, the part that public opinion plays through the operation of the jury system, the lack of detailed legislation—it would have very serious effects on the interpretation of Aristotle's conception of equity, the rule of law, and of natural, written, and unwritten law. I do not think that it would alter basically Dr. Hamburger's interpretation, but it would localize Aristotle's doctrines in time and make us more cautious in transplanting them for use in the modern world.

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Plato's Phaedrus. Translated with Introduction and Commentary by R. Hackforth. Cambridge: At the University Press. 1952. vii, 172 pp. $3.75.

This is the first commentary on the *Phaedrus* to appear in English since Thompson's of 1868. In agreement with Jaeger, Robin, Stenzel, von Frutiger, and Wilamowitz, Professor Hackforth places the *Phaedrus* between the *Republic* and the *Sophist*—about the time of the *Theaetetus*. He argues that the doctrine of the soul's

self-motion which appears in the *Phaedrus* and *Laws* was not entertained by Plato when he wrote the *Phaedo* and *Republic;* that the figure of the charioteer with steeds and the reference to "determination by lot and choice" in the *Phaedrus* would be "barely intelligible" to persons unacquainted with Books IV and X respectively of the *Republic.* His most impressive evidence is his own commentary, from which much of the dialogue in question emerges as a recapitulation of what Plato had written in works here deemed earlier and, again, as a transition to such late writings as the *Sophist, Statesman,* and *Philebus.* He sees in the *Phaedrus* a new consideration of questions previously raised by Plato on love in the *Symposium,* on immortality in the *Phaedo* and *Republic,* poetry in the *Ion, Apology, Meno,* and *Republic,* reminiscence in the *Meno* and *Phaedo,* the parts of the soul, knowledge, and dialectic in the *Republic,* and so on. The author notes that of the two *dramatis personae,* Socrates and Phaedrus, the latter is "not painted in strong colours" in the dialogue which bears his name. Phaedrus has already been introduced to readers of the *Symposium* as a rhetorician of sorts, and they have been informed by the *Protagoras* of his association with the sophist Hippias. Professor Hackforth detects evidence in three passages of the *Phaedrus,* 238d, 241e, 263d, of a susceptibility on the part of Socrates "to the influence of external Nature felt as a power lifting him out of his normal rational self into a state of 'possession' (ἐνθουσιασμός)." Others, no doubt, will interpret these passages differently and attribute Socrates' "state" to the influence of "*mutae personae* . . .the divinities of the place."

The author disposes of the oft-debated question of the "subject" of the *Phaedrus*—whose topics are many and varied— by seeking "purpose" in the dialogue. He finds a threefold design, with interdependent themes: the vindication of the pursuit of philosophy as love ("the whole-hearted devotion to a quest"), proposals for a reformed rhetoric, and the announcement and exemplification of a dialectical method. The question of the authorship of the speech of Lysias—whether by Plato or the rhetorician himself—confronts Professor Hackforth, as it did Shorey, with a "deadlock." Diogenes Laertius and Hermeias of old and such moderns as Blass, Hude, Taylor, Vahlen, and Wilamowitz argue that Lysias wrote it; Croiset, Diès, Shorey, and Weinstock think Plato its author. Professor Hackforth sides with the latter group. He is, one gathers, not disposed to accept the opinion that Plato was given to compiling dramas from quotations. The setting up of Lysias as a "target" for criticism in a speech of Plato's own making occasions the reflection, "No doubt such a procedure seems to us grossly un-

fair and stupid." This is a gratuity which will hardly appease zealots among the followers of Diogenes Laertius.

Readers of the Introduction should not be put off by what may look like a confusion between "enthusiasm" and its extreme opposite, mysticism, by a hedging about the "mystical side of the Platonic Socrates," the refusal to cite evidence while naming authors, the presentation of commonplaces in Gallic dress, the having Socrates think in German when he ruminates—no doubt sentimentally—on an afternoon on the bank of the Ilissus, or by the adduction of Bertrand Russell's *History of Western Philosophy*, p. 109, as an authority on Socratic "trances."

Professor Hackforth's translation is made in a plain and durable English devoid of "technical" barbarisms and philosophic shibboleths. Portions of it describe sexual love. These are written without verbal fuss and without recourse to Freudian, mystical, or other sublimations. Innocents who read his English will escape the impression that the Apostle Paul, church fathers, Kant, Hegel, Husserl, Whitehead, and anglo-catholic theologians made contributions to the original Plato. The translator has not found it necessary to rewrite the Greek text in order to render the dialogue intelligible or to "read between the lines" to make a thinker out of an author of philosophic dramas. Nor has he required Plato to say the opposite of what he wrote by an appeal to Socratic sarcasm. He accepts at face value Socrates' acknowledgment that the rhetorician Isocrates shows "tincture" and unfulfilled promise of philosophic reflection.

A translator's choice of words can make for the concealment of difficulties. A case in point is the rendering of τέχνη, in 245a, by the indeterminate word "skill"—which can apply indifferently to "knack" (τριβή), "art" (τέχνη), and dialectic. In 245a there is an emphatic statement of the opposition between two current conceptions of poetry, one of poetry as technical art, the other of poetry as inspiration. If, as the commentator says, "it was of course the traditional belief that poets are inspired by Apollo and the Muses," it was also an opinion among some, perhaps very many, contemporaries of Socrates that poetry is a technique, comparable in method to shoemaking and medicine. The problem of reconciling either or both of these views with a profession of wisdom on the part of the poets is one bequeathed from the *Ion* and *Apology*. In his comments on the section within which 245a falls the author considers the question of reconciling poetic "madness" and the knowledge of the "rationalist" and completely disregards the problems occasioned by the presence of τέχνη. He rejects, as unsatisfactory, the suggestion of Professor Tate that "the inspired poet when

wrong has the symptoms of inspiration without the reality" and is "inclined to explain" what he calls "the negative aspect of ἐνθουσιασμός (or, as the *Phaedrus* calls it, of θεία μανία)" by the consideration that "Plato himself is a compound of rationalist and poet" and whereas in other dialogues the "estimate of poets and poetry reflects both elements of the compound in fairly equal degrees, in the *Phaedrus* the poet definitely gets the upper hand." This solution, needless to say, will strike some readers as a begging of the question.

In the commentaries severally on twenty-six parts of the dialogue discussion is directed throughout to the content of the *Phaedrus* itself. There is no intrusion by external "systems," Pythagorean, Thomist, Hegelian, or neo-Kantian. Students who have found resting-place and complacent ease in a Platonic "synthesis" would do well to read the commentary.

The author does permit, however, an intervention by what many readers will consider an extra-Platonic empiricistic epistemology. He pronounces unsound the argument for immortality in the *Phaedo* on the ground there that the soul's participation in the Form of life precludes its partaking of death. "Stripped of the terminology of the Ideal theory," he says, "this amounts to saying that the notion of life is bound up with the notion of soul, and what it really yields is not (as Socrates maintains) the conclusion that soul is immortal but the tautological proposition that as long as soul exists it is alive. What the *Phaedrus* does is to remould an argument about the relations of words and concepts into one based on observed physical fact, the fact namely of κίνησις. Life, it argues, is bound up with the soul because the observed processes or movements which constitute life can only be accounted for by the postulate of a self-moving soul, and the eternity of that self-moving soul is the necessary presupposition of all physical existence. Although it would be too much to say that the *Phaedrus* provides an empirical metamorphosis of the *Phaedo's* metaphysical or 'rationalist' argument, yet it is rooted, as the other is not, in empirical fact, and that is why Aristotle, whose thought has far more kinship with empiricism than Plato's normally has, is so largely indebted to our present argument for his doctrine of an eternal—albeit unmoved —First Mover."

The interesting discovery that the doctrine of an unmoved First Mover has "kinship" with a non-rationalistic empiricism disregarded, this ingenious piece of exegesis will undoubtedly surprise students of Plato who recall that the argument respecting Forms in the *Phaedo* is, according to Socrates' own account, the result of his attempt to discover a valid epistemological way of dealing with

physical facts and processes. The contention that in the *Phaedrus* (245c–246a) there is a remolding according to empiricist "fact," "postulate," and "presupposition" of what is merely verbal in the *Phaedo* is undoubtedly an extravagance. Conceivably—since we are now in the realm of supposition—Plato might prefer an assessment of his major argument for immortality in the *Phaedo* by means of a logic in which convertible propositions—without a conditioning "as long as"—would not be deemed mere verbal tautologies when the terms are taken to be "rooted" in what the commentator in another conjunction calls "reality." Platonic "rationalism" does not yield itself to "empirical metamorphosis" for the reason that its philosophic Eros is not of sights, sounds, tastes, smells, and their verbal signs plus postulates.

An instructive part of Professor Hackforth's commentary—everywhere suggestive and generally illuminating—is his treatment of dialectic and the approach to it through rhetoric. In the *Phaedrus* dialectic is said to include "collection" and "division." By the former particulars are brought under Forms and "narrower" Forms put under those of a "wider" sort. Division as such is not concerned with particulars, and terminates with *infimae species*. Contemporary rhetoric is found to be "no τέχνη, no true art, for it knows nothing of dialectic, the sovereign method of philosophy; but it can, Plato suggests, become a τέχνη by basing itself on dialectic and psychology." The approach to dialectic by way of the four stages of knowledge described in Book VI of the *Republic* has been superseded and transition made to a new epistemology which undergoes development in the *Statesman* and *Philebus*. Hitherto the Form of the Good, source of being and knowing, has been the goal of dialectical endeavor. Now and hereafter there is no "notion of deriving all the truths of philosophy and science from a single first principle; and we may not unreasonably conjecture that the ontological and epistemological flights of the *Republic* have been superseded by something less magnificent, but perhaps more practicable . . . a mapping out of one field after another by a classification *per genera et species* which will have the effect of at once discriminating and relating these concepts or class-names which express not mere subjective generalisations but the actual structure of reality." Here the reader may, rightly or wrongly, detect with dissatisfaction a common rejection for identical reasons of both unreformed rhetoric and Plato's earlier theory of knowledge. He may also reflect that the equating of concepts with class-names and the sundering of the subjective and the objective within Platonic epistemology are both practices with large consequence.

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Ontology. JAMES K. FEIBLEMAN. Baltimore: The Johns Hopkins Press. 1951. xix, 807 pp. $9.75.

It was to be expected that Mr. James K. Feibleman would sooner or later produce a philosophical system. The present large book, representing "little more than a rough third draft," expounds the system under the title of "axiologic realism" or "the ontological philosophy." Subsequent developments are apparently envisaged, since the preface states that "a second, revised edition is planned." While the exposition of the system constitutes "the heart of the work" (p. 184), the primary aim is said to be "the establishment, among scientifically-minded men, of speculative ontology as a legitimate field of inquiry" (p. vii). Part One is devoted to this task. Parts Two and Three, making up almost three-quarters of the book, set forth a particular system of ontology, together with some of its alleged implications for epistemology and logic.

A rough idea of Mr. Feibleman's conception of ontology may be gathered from such statements as the following.

> Ontology . . . is equivalent to the widest of any finite set of systems of knowledge. It aims to be a description in finite terms of the universe . . . to understand and explain, in so far as that is possible, the whole of the known world. [P. 121.]

The form in which an ontology should be cast is that of an axiomatic system, with undefined terms, postulates, and an array of deductions. The requirements of such a system are "self-consistency, simplicity and sufficiency" (p. 124) or "consistency, completeness and applicability" (p. 115). It is also laid down that the undefined concepts ("ontological categories") should be the fewest allowable and the most necessary. Indeed, "the primary ontological categories must not be more than three in number" (p. 129). Postulates are chosen so as to yield deductively "the laws, generalizations, hypotheses and empirical facts presented by every field of knowledge: data made available by the sciences, the arts, and by those practical or technical fields which have not yet been made into either sciences or arts . . ." (p. 126). Ontology thus takes considerably more than all knowledge for its province!

This quasi-mathematical approach, according to Mr. Feibleman, turns the edge of certain hostile criticisms that have been made of traditional metaphysics. For it is now possible to regard any ontological system as tentative and hypothetical, rather than absolute and final. A plurality of competing systems can be admitted, some more adequate than others, but none conclusively demonstrated. In the strict scientific sense, an ontological system *cannot* be demonstrated at all. Yet "the demonstrations of science

are made possible by the assumption of the proper ontology" (p. 102). That is why an "implicit ontology" underlies not only the sciences but also the outlook of common sense and even of tough-minded positivists. Ontology, it seems, is as unavoidable as death and taxes.

The particular system which Mr. Feibleman favors is based on "the three primary categories: essence, existence and destiny" (p. 282). Since any suggestion of nominalism is anathema, these are understood to be the names of three "universes of being." Destiny is, however, subordinate to the other two. It represents not so much a separate universe as "the tendency to movement" of the universe of existence towards the universe of essence (p. 215). One might have expected that the primary categories would be the undefined terms of the system. But this is not so. Essence is *defined* as "the power to affect or to be affected" (p. 212). It is synonymous with possibility. "The universe of essence is posited as a complete system" (p. 398), having the properties of "continuity, plenitude and gradation" (p. 206). Existence is *defined* "as whatever affects or is affected" (p. 215). It is synonymous with nature. "The universe of existence is only partly systematic, inasmuch as there are internal contradictions, chance occurrences, disvalues" (p. 398). The properties of this universe "are privation, discontinuity and inequality" (p. 286). Destiny is defined in the terms mentioned above. Another name for it "might be teleology, which indeed is the meaning of destiny" (p. 398).

Even if the space were available, I should not be able to say very much about the elaborate "series of integrative levels" which Mr. Feibleman purports to find in each of the three "universes." His discussion becomes so obscure that I am unable to get any clear idea of its meaning. Nor would there seem to be much point in trying to deal with the postulates laid down, except to mention that 117 are given for the universe of essence, 160 for the universe of existence, and 123 for the universe of destiny. In addition, 111 postulates for the special case of epistemology and 88 postulates for the "all-presumptive calculus" are listed (pp. 664–684). As far as I can see, none of these postulates are used to effect formal proofs, so that the axiomatic character of Mr. Feibleman's system is illusory. He relies wholly on a discursive mode of presentation, wherein many things are asserted but without benefit of proof.

Much labor has undoubtedly gone into the writing of this book. Yet it seems to me to have grave shortcomings. For one thing, far too many topics receive only a superficial treatment. Thus, fourteen lines are devoted to justifying the contention that there must be not more than three primary categories (p. 129). The complex

question of counterfactual conditionals is brushed off in a paragraph (p. 239). About two pages suffice for the discussion of probability (pp. 436–438). And so on. Often the order in which Mr. Feibleman takes up various topics seems quite arbitrary. Since their logical connections are not made clear, the topics create the impression of being arranged to suit the whim of the author, and hence the treatment is lacking in rigor. Finally, Mr. Feibleman's language frequently falls below the standard of precision which we nowadays expect of a significant philosophical work. Most readers will not be impressed by the statement that "there is a point at which philosophy requires vagueness, that point at which it tries to use language to get beyond language, to break through language to express values which are inexpressible" (p. 149). No matter how encyclopedic "ontology" may try to be, it will hardly attract "scientifically-minded men" as long as it is deficient in thoroughness, precision, and rigor. Such men require something more than "a rough third draft" of a system to be convinced that ontology is "a legitimate field of inquiry."

I have noticed the following misprints: p. 61, l. 14, for "Pierce" read "Peirce"; p. 225, l. 31, for "unforunately" read "unfortunately"; p. 367, l. 15, for "or" read "of"; p. 523, l. 34, for "totaliy" read "totality."

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Science and Humanism; Physics in Our Time. ERWIN SCHRÖDINGER. Cambridge: At the University Press. 1951. 68 pp. $1.75.

This little book contains a number of desultory reflections on modern physics which Schrödinger presented in four public lectures under the auspices of the Dublin Institute for Advanced Studies. Schrödinger's comments are naturally of great interest, though none of them are elaborated with the fullness that the subject requires and deserves. He maintains that the ultimate aim of science is not practical control over nature, but to find an answer to the Plotinian question "Who are we, anyhow?" However he does not even suggest how contemporary physics contributes to this problem; and at the one place where he touches on specific human concerns he argues with Cassirer—very cogently in the opinion of the present reviewer—that it is absurd to base ethics and the doctrine of free-will on the indeterminism of sub-atomic processes assumed by current physics. He asserts that in the light of modern discoveries matter is "much less materialistic" than it was once supposed to be, and maintains that the ultimate particles of subatomic physics are not "individuals" in any proper sense, and are

"as it were" nothing but pure form rather then substance. And because matter is allegedly only an "image in our mind," mind is said to be "prior to matter." It is obvious that there are lacunae in this argument, but if the missing steps can be supplied Schrödinger does not provide them.

The fullest discussion of the book is devoted to the analysis of the grounds advanced in sub-atomic physics for denying the possibility of a "continuous [or strictly causal] description" of sub-atomic processes. In this connection Schrödinger is highly suggestive. He notes that wave mechanics does in fact conform to the classical ideal of such "description," but that while it gives a continuous description of *something*, that "something" is not observed or observable fact. Accordingly, he calls attention to what is surely the crucial but generally neglected point that there is no one-to-one correspondence between the elements of the mathematical formalism employed in wave-mechanics and the observable items of experience. The hypothesis is therefore almost inescapable, though Schrödinger does not mention it, that many of the apparently paradoxical features of quantum theory arise from misplaced efforts to assign a *literal* meaning to all expressions of that theory by correlating them in a one-to-one fashion with visualizable (or otherwise directly experienceable) traits of everyday things.

Finally, Schrödinger has some critical comments on the view, associated especially with Bohr and Heisenberg, that quantum mechanics requires us to abandon the distinction between "subject" and "object." But the chief reason he gives for rejecting that thesis is that since "mind" is not a physical system, it obviously cannot interact with physical systems, so that the alleged "interference" of observer with what is observed in micro-physical experiments is not relevant to what the distinction is supposed to assert. This is a sound enough point against those who maintain that there is something "subjective" in "observations" of sub-microscopic processes; it is however not a fully adequate disposal of the questions at issue. Nevertheless, despite the brevity and occasionally the cryptic quality of Schrödinger's remarks, his little book is enormously stimulating and eminently worth reading.

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T. V. Smith, Maxwell Professor of Citizenship and Philosophy at Syracuse University, will give the Chancellor Dunning Trust Lectures for the academic year 1952–1953 at Queen's University, Ontario.

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